

## 15

driver 630 is a string type, which is integrated with CPU function. A solar cell 600 is integrated on the substrate as a power source for the whole apparatus. Transmitting and receiving information to/from externals are performed by input/output sensors 610 (for example LED and photodiode) integrated on the substrate. In accordance with the present embodiment, many members, such as the electric power source, the back light, the substrate mounting the control circuits, FPC., and container, can be omitted, and accordingly, the apparatus can be reduced in weight, in size, and in thickness. The portability of the information processor can be improved remarkably. As a similar embodiment, an example which uses a string driver and mounts a CPU630 on the substrate is shown in FIG. 16. FIG. 15 shows an example wherein all elements are integrated on the substrate. In both cases, the portability of the apparatus can be improved remarkably.

As described above, in accordance with the present invention, the active matrix liquid crystal display apparatus can be reduced in size, and the portability of the liquid crystal display apparatus can be improved.

What is claimed is:

1. A liquid crystal display apparatus, comprising:
  - a pair of substrates, at least one of which is transparent;
  - a liquid crystal layer formed by enclosing a liquid crystal composition between said pair of substrates;
  - a display region having a plurality of first semiconductor elements which are arranged in a matrix on one substrate of said pair of substrates;
  - peripheral circuits having a plurality of second semiconductor elements for driving said plurality of first semiconductor elements, arranged at a periphery of said display region, said peripheral circuits formed on said one substrate of said pair of substrates and at least a part of said peripheral circuit are arranged in a peripheral circuits region which is held between said pair of substrates; and
  - at least one driver circuit which is an integrated circuit for driving said peripheral circuits is formed on said one substrate of said pair of substrates in a driver integrated circuit region which is not held between said pair of substrates.
2. A liquid crystal display apparatus as claimed in claim 22, wherein said first and second semiconductor elements are thin film transistors.
3. A liquid crystal display apparatus as claimed in claim 2, wherein
  - said thin film transistors at the display region have a mobility in a range of  $1 \text{ cm}^2/\text{Vs}$  to  $5 \text{ cm}^2/\text{Vs}$ ;
  - said thin film transistors at the peripheral circuits region have a mobility in a range from  $10 \text{ cm}^2/\text{Vs}$  to  $30 \text{ cm}^2/\text{Vs}$ ; and
  - the amplitude of a liquid crystal driving voltage of the driver circuit is at most 5 V.
4. A liquid crystal display apparatus as claimed in claim 2, wherein
  - said thin film transistors at the display region have a mobility in a range of  $0.7 \text{ cm}^2/\text{Vs}$  to  $5 \text{ cm}^2/\text{Vs}$ ;
  - said thin film transistors at the peripheral circuits region have a mobility in a range from  $30 \text{ cm}^2/\text{Vs}$  to  $100 \text{ cm}^2/\text{Vs}$ ; and
  - the amplitude of a liquid crystal driving voltage of the driver circuit is at most 5 V.
5. A liquid crystal display apparatus as claimed in claim 2, wherein

## 16

said thin film transistors at the display region have a mobility in a range of  $0.4 \text{ cm}^2/\text{Vs}$  to  $5 \text{ cm}^2/\text{Vs}$ ;

said thin film transistors at the peripheral circuits region have a mobility in a range from  $100 \text{ cm}^2/\text{Vs}$  to  $300 \text{ cm}^2/\text{Vs}$ ;

the amplitude of a liquid crystal driving voltage of the driver circuit is at most 5 V; and

a softening point of said one substrate of said pair of substrates is at most  $600^\circ\text{C}$ .

6. A liquid crystal display apparatus as claimed in claim 2, wherein
  - the thin film transistors at said display region have a switching time in a range from  $30 \mu\text{s}$  to  $60 \mu\text{s}$ ;
  - the thin film transistors at said peripheral circuit region have a switching time in a range of  $3 \mu\text{s}$  to  $12 \mu\text{s}$ ; and
  - said driver circuit has a transistor having a switching time in a range from  $0.01 \mu\text{s}$  to  $0.03 \mu\text{s}$ .
7. A liquid crystal display apparatus as claimed in either of claim 1 or claim 2, wherein
  - said driver is bonded directly to said one substrate of said pair of substrates.
8. A liquid crystal display apparatus as claimed in claim 1, wherein
  - said pair of substrates are made of glass.
9. A liquid crystal display apparatus as claimed in claim 8, wherein
  - said driver is bonded to said one substrate of said pair of substrates by a COG (chip on glass) method.
10. A liquid crystal display apparatus as claimed in claim 1, wherein
  - the number of driver circuits bonded to said one substrate of said pair of substrates is one.
11. A liquid crystal display apparatus as claimed in claim 1, wherein
  - said peripheral circuits region comprises:
    - a signal circuit at an image signal side of said display region for supplying an image signal to said plural first semiconductor elements arranged in said display region; and
    - a signal circuit at a scan signal side of said display region for supplying a scan signal to said plural first semiconductor elements.
12. A liquid crystal display apparatus as claimed in claim 11, wherein
  - the number of driver circuits bonded to said other substrate of said pair of substrates is two, and
  - respective ones of said driver circuits are arranged adjacent to said signal circuit at said image signal side and at said scan signal side of said display region, respectively.
13. A liquid crystal display apparatus as claimed in claim 1, wherein
  - the diagonal length of said display region is in a range from  $75 \text{ mm}$  to  $175 \text{ mm}$ ; and
  - the distance from the outer periphery of the display region to the outer periphery of the liquid crystal display apparatus is at most  $5 \text{ mm}$ .
14. A liquid crystal display apparatus as claimed in claim 1, wherein
  - the ratio of the area of said display region to the area of said one substrate of said pair of substrates is in a range from  $70\%$  to  $95\%$ .
15. A liquid crystal display apparatus as claimed in claim 1, wherein

**17**

the distance between said driver circuit and said peripheral circuit region is at most 1 mm.

16. A liquid crystal display apparatus as claimed in claim 1, wherein  
a light-shield film is formed on said peripheral circuit region.
17. A liquid crystal display apparatus as claimed in claim 1, wherein  
a driver circuit is provided at only a short side of said one substrate of said pair of substrates.
18. A liquid crystal display apparatus as claimed in claim 1, wherein  
a driver circuit is provided at only a long side of said one substrate of said pair of substrates.
19. A liquid crystal display apparatus as claimed in claim 1, wherein  
a threshold voltage of said liquid crystal layer is at most 2 V.
20. A liquid crystal display apparatus as claimed in claim 1, wherein  
the active region of said first and second semiconductor elements are made of amorphous silicon and polycrystalline silicon; and  
the active region of said semiconductor elements comprising said driver circuit is made of single crystalline silicon.
21. A liquid crystal display apparatus according to claim 1, wherein another part of said peripheral circuits is arranged

**18**

in said driver integrated circuit region which is not held between said pair of substrates.

22. A liquid crystal display apparatus comprising:  
a pair of substrates, at least one of which is transparent;  
a liquid crystal layer formed by enclosing a liquid crystal composition between said pair of substrates;  
a display region, having a plurality of first semiconductor elements which are arranged in a matrix is formed on one substrate;  
a peripheral circuits region having a plurality of second semiconductor elements for driving said plurality of first semiconductor elements, arranged at a periphery of said display region, are formed on said one substrate of said pair of substrates;  
at least one driver circuit for driving said peripheral circuits bonded at a designated region on said one substrate of said pair of substrates;  
wherein said first and second semiconductor elements are thin film transistors; and  
the thin film transistors at said display region have a switching time in a range from 30  $\mu$ s to 60  $\mu$ s;  
the thin film transistors at said peripheral circuit region have a switching time in a range of 3  $\mu$ s to 12  $\mu$ s; and  
said driver circuit has a transistor having a switching time in a range from 0.01  $\mu$ s to 0.03  $\mu$ s.

\* \* \* \*

*sw  
pw*

23. A liquid crystal display apparatus comprising:  
a pair of substrates, at least one of which is  
transparent;  
a liquid crystal layer formed by sandwiching a liquid  
crystal composition between said pair of substrates;  
a display region having a plurality of first  
semiconductor elements which are arranged in a matrix on one  
substrate of said pair of substrates;  
at least one peripheral circuit having a plurality of  
second semiconductor elements arranged at a periphery of said  
display region, said at least one peripheral circuit being  
formed on said one substrate of said pair of substrates and at  
least one part of said peripheral circuit being arranged in a  
peripheral circuit region which is held between said pair of  
substrates; and  
at least one driver circuit which is electrically  
connected to said at least one peripheral circuit for driving  
said at least one peripheral circuit.

*hr  
w*

24. A liquid crystal display apparatus according to  
claim 23, wherein said at least one driver circuit is separate  
from said pair of substrates.

25. A liquid crystal display apparatus according to  
claim 23, wherein said display region having said plurality of  
first semiconductor elements has at least one semiconductor  
island annealed by laser irradiation.

*sub  
b3*

26. A liquid crystal display apparatus according to claim 23, wherein an amplitude of a liquid driving source voltage of said at least one driver circuit is in a range of about 3V to about 5V.

27. A liquid crystal display apparatus according to claim 26, wherein said at least one peripheral circuit includes said plurality of second semiconductor elements having at least one semiconductor island annealed by laser irradiation.

28. A liquid crystal display apparatus according to claim 27, wherein the laser irradiation is provided by an excimer laser.

29. A liquid crystal display apparatus according to claim 28, wherein said at least one driver circuit is a single driver circuit.

30. A liquid crystal display apparatus according to claim 28, wherein said at least one driver circuit includes two driver circuits.

31. A liquid crystal display apparatus according to claim 28, wherein said plurality of second semiconductor elements are thin-film transistors, and said thin-film transistors have a mobility in the range of 100 cm<sup>2</sup>/Vs to 300 cm<sup>2</sup>/Vs.

*b4*

32. A liquid crystal display apparatus comprising:  
a pair of substrates, at least one of which is  
transparent;

a liquid crystal layer formed by sandwiching a liquid  
crystal composition between said pair of substrates;

a display region having a plurality of semiconductor  
elements arranged in a matrix on one substrate of said pair of  
substrates;

an image signal peripheral circuit which consists of a  
switch matrix connected to said display region on one  
substrate of said pair of substrates; and

at least one driven circuit electrically connected to  
said image signal peripheral circuit.

33. A liquid crystal display apparatus according to  
claim 32, wherein a scanning signal peripheral circuit is  
connected to said display region and is formed on one  
substrate of said pair of substrates.

*b5*

34. A liquid crystal display apparatus according to  
claim 32, wherein at least one of said image signal peripheral  
circuit and said scanning signal, the peripheral circuit  
includes a plurality of semiconductor elements having at least  
one semiconductor island annealed laser irradiation.

35. A liquid crystal display apparatus according to  
claim 34, wherein the laser irradiation is excimer laser  
irradiation.

36. A liquid crystal display apparatus according to claim 35, wherein the laser irradiation is provided by an XeCl excimer laser.

37. A liquid crystal display apparatus according to claim 36, wherein said switch matrix comprises thin-film transistors, and said thin-film transistors have a mobility in the range of 100 cm<sup>2</sup>/Vs to 300 cm<sup>2</sup>/Vs.

38. A liquid crystal display apparatus comprising:  
a pair of substrates, at least one of which is transparent;  
a liquid crystal layer formed by enclosing a liquid crystal composition between said pair of substrates;  
a display region having a plurality of semiconductor elements arranged in a matrix form on one substrate of said pair of substrates;  
at least one image signal peripheral circuit having a switch matrix connected to said display region; and  
at least one driver circuit, including at least one display information generating circuit, electrically connected to said at least one image signal peripheral circuit.

39. A liquid crystal display apparatus according to claim 38, wherein said at least one image signal peripheral circuit includes a plurality of semiconductor elements having at least one semiconductor island annealed by laser irradiation.

~~40. A liquid crystal display apparatus according to claim 39, wherein the laser irradiation is provided by an excimer laser.~~

~~41. A liquid crystal display apparatus according to claim 37, wherein said excimer laser is a XeCl excimer laser.~~

~~42. A liquid crystal display apparatus comprising:  
a pair of substrates, at least one of which is transparent;  
a liquid crystal layer formed by sandwiching a liquid crystal composition between said pair of substrates;  
a display region having a plurality of first semiconductor elements arranged in a matrix form on one substrate of said pair of substrates; and  
an image signal peripheral circuit having a switch matrix connected to said display region;  
wherein only one driver circuit is electrically connected to said image signal peripheral circuit for generating clock pulses and analog image signals.~~

~~43. A liquid crystal display apparatus according to claim 42, wherein said image signal peripheral circuit includes a plurality of semiconductor elements having at least one semiconductor island annealed by laser irradiation.~~

~~44. A liquid crystal display apparatus according to claim 43, wherein the laser irradiation is provided by an~~

excimer laser.

45. A liquid crystal display apparatus according to  
claim 44, wherein said excimer laser is a XeCl excimer laser.

A<sup>57</sup>  
B8